

PROCEEDINGS
OF
THE ROYAL SOCIETY.

1833-1834.

No. 17.

May 15, 1834.

MARK ISAMBARD BRUNEL, Esq., Vice-President, in the Chair.

A paper was read, entitled, "Of the Functions of some parts of the Brain; and of the relations between the Brain and Nerves of Motion and Sensation." By Sir Charles Bell, K.H., F.R.S.

The author commences his paper by an enumeration of some of the sources of difficulty and of error which have impeded the progress of discovery in the physiology of the brain; the first impediment to which, he observes, "is in the nature of the inquiry, since extraordinary and contradictory results must be expected from experimenting on an organ so fine as that must be which ministers to sensibility and motion, and which is subject to change on every impression conveyed through the senses." Another cause of fallacy is the dependence of the brain on the condition of the circulation within it: but the most frequent source of error is the obscurity which hangs over the whole subject; for although the brain be divided naturally into distinct masses, not one of these grand divisions has yet been distinguished by its functions; and hence we may account for the failure of all attempts to explain the phenomena which attend injury of the brain. The principle, now universally admitted, that nerves have distinct functions, and not a common quality, is pursued by the author in his investigation of the structure of the brain, in which he follows the nerves into that organ, and observes the tracts of nervous matter from which they take their origin. He concludes from his inquiries that both sensibility and motion belong to the cerebrum; that two columns descend from each hemisphere; that one of these, the anterior, gives origin to the anterior roots of the spinal nerves, and is dedicated to voluntary motion; and that the other, which from its internal position is less known, gives origin to the posterior roots of the spinal nerves, and to the sensitive root of the fifth nerve, and is the column for sensation. He further shows that the columns for motion, which come from different sides of the cerebrum, join and decussate in the medulla oblongata; that the columns of sensation also join and decussate in the medulla oblongata; and lastly, that these anterior and posterior columns bear, in every circumstance, a very close resemblance to one another, in as much as the sensorial expansions of both are widely extended in the hemispheres; for they pass through similar bodies towards the base of the brain, and both

concentrate and decussate in the same manner; thus agreeing in every respect, except in the nervous filaments to which they give origin. Hence he explains the phenomena of the loss of sensibility as well as the power of motion of one side of the body, consequent on injuries of the other side of the brain.

The Society then adjourned over Whitsun Week to the 29th of May.

May 29, 1834.

JOHN WILLIAM LUBBOCK, Esq., M.A., V.P. and Treasurer,
in the Chair.

A paper was read, entitled, "On the Principle of Construction and General Application of the Negative Achromatic Lens to Telescopes and Eyepieces of every description." By Peter Barlow, Esq., F.R.S.

This paper is intended as a more full illustration of the principles on which the negative achromatic lens is constructed and applied, than has been given in the extract from the author's letter to Mr. Dollond, contained in the paper of the latter, lately read to the Society, on his ingenious application of that lens to the micrometer eyepiece. The author shows that its advantages are not confined to this instrument, but that it is applicable to any eyepiece positive or negative to the erecting eyepiece, and, indeed, to any telescope of fluid or glass, and also to refractors.

A paper was also read, entitled, "Some remarks in reply to Dr. Daubeny's Note on the Air disengaged from the Sea over the site of the recent Volcano in the Mediterranean." By John Davy, M.D., F.R.S. Assistant Inspector of Army Hospitals.

Respecting the air in question, which Dr. Davy had found to consist of about 80 per cent. of azote and 10 oxygen, he had remarked that two views might be taken of its origin; the one, that it was of volcanic source; the other, that it was derived from the sea water, and merely disengaged by the heat of the volcano. Dr. Davy, rejecting the former of these views, had adopted the latter, for reasons, the validity of which was controverted by Dr. Daubeny; and the purpose of the present paper is to answer the objections urged against them, and to bring additional evidence in support of his opinion.

A paper was then read, entitled, "On the number of Primitive Colorific Rays into which White Light may be separated." By Paul Cooper, Esq. Communicated by J. G. Children, Esq. Sec. R.S.

From a consideration of the circumstances in which white light is decomposed by the prism, in different experiments, and of the various appearances of the spectra which result, the author is led to the opinion that the primary colours composing white light are not seven, as conceived by Newton; nor four, as supposed by Wollaston; but only three: and that these three are not red, yellow, and

blue, as imagined by Brewster, but red, green, and violet; the first and last forming the terminal parts of the spectrum, and the green occupying an intermediate position; and the various tints which intervene being the result of superpositions, in various quantities, of these respective primary colours. He pursues the consequences of this hypothesis, applying it to a great variety of forms of experiment, not only by the direct observation of beams of refracted light, but by viewing the prismatic spectrum through different media, capable of absorbing each of the primitive colours in different degrees: and he finds the results to accord exactly with the hypothesis he proposes, and on which he therefore concludes that their true explanation must be founded. He conceives that the errors of preceding experimentalists have arisen from their neglecting to take into account the effects of diffraction, which introduces considerable confusion into the results.

A paper was also read, entitled, "An Investigation of the Laws which govern the Motion of Steam-Vessels, deduced from experiment." By P. W. Barlow, Esq. Civil Engineer. Communicated by Dr. Roget, Sec. R.S.

The author commences with the description of a paddle wheel for steam-vessels, of a new construction, in which the floats are made to enter and leave the water nearly in a vertical position. He then investigates several formulæ adapted to the calculation of the forces and velocities arising from this form of the apparatus; and gives an account of the results of various experiments made on its efficiency as compared with the common wheels, and with relation to the consumption of fuel. The general results to which he is led are as follow:—1st. When vessels are so laden as that the wheel is but slightly immersed, little advantage is derived from the vertically acting paddles. 2ndly. In cases of deep immersion, the latter has considerable advantage over the wheel of the usual construction. 3rdly. In the common wheel, while the paddle passes through the lower portion of the arc, that is when its position is vertical, it not only affords less resistance to the engine, but is less effective in propelling the vessel than in any part of its revolution. 4thly. The paddle of the wheel, while passing through the lower portion of the arc, affords more resistance to the engine, and is more effective in propelling the vessel, than in any part of its revolution; a property which is a serious deduction from its value; for, in consequence of the total resistance to all the paddles being so much less than in the common wheel, much greater velocity is required to obtain the requisite pressure, and a greater expenditure of steam power is incurred. This loss of power is most sensible when the wheel is slightly immersed; but in cases of deep immersion the vertical paddle has greatly the advantage. 5thly. In any wheel, the larger the paddles the less is the loss of force; because the velocity of the wheel is not required to exceed that of the vessel in so great a degree, in order to acquire the resistance necessary to propel the vessel. 6thly. With the same boat and the same wheel no advantage is gained by reducing the paddle so as to

bring out the full power of the engine ; the effect produced being simply that of increasing the speed of the wheel, and not that of the vessel. 7thly. An increase of speed will be obtained by reducing the diameter of the wheel ; at least within such limits as allow of the floats remaining sufficiently immersed in the water ; and provided the velocity of the engine does not exceed that at which it can perform its work properly. 8thly. An advantage would be gained by giving to the wheel a larger diameter, as far as the immersion of the paddles produced by loading the vessel would not so sensibly affect the angle of inclination of the paddle ; but this advantage cannot be obtained with an engine of the same length of stroke, because in order to allow the engine to make its full number of strokes, it will then be necessary to diminish the size of the paddles, which is a much greater evil than having a wheel of smaller diameter with larger paddles.

The reading of a paper was then commenced, entitled, "On the Equilibrium of a Mass of Homogeneous Fluid at liberty." By James Ivory, Esq., K.H., M.A., F.R.S.

June 5, 1834.

FRANCIS BAILY, Esq., Vice-President, in the Chair.

John Marquess of Breadalbane ; Charles John Lord Teignmouth ; the Hon. George Elliot, R.N. ; the Rev. Frederick William Hope, M.A. ; Joseph Jekyll, jun., Esq., M.A. ; the Rev. Robert Murphy, M.A. ; the Hon. Sir George Rose ; Richard Twining, Esq. ; William Robert Whatton, Esq. ; and George Witt, M.D., were elected Fellows of the Society.

Mr. Ivory's paper, entitled, "On the Equilibrium of a Mass of Homogeneous Fluid at liberty," was resumed and concluded.

The author shows that Clairaut's theory of the equilibrium of fluids, however seductive by its conciseness and neatness, and by the skill displayed in its analytical construction, is yet insufficient to solve the problem in all its generality. The equations of the upper surface of the fluid, and of all the level surfaces underneath it, are derived, in that theory, from the single expression of the hydrostatic pressure, and are entirely dependent on the differential equation of the surface. They require, therefore, that this latter equation be determinate and explicitly given ; and accordingly they are sufficient to solve the problem when the forces are known algebraical expressions of the co-ordinates of the point of action ; but they are not sufficient when the forces are not explicitly given, but depend, as they do in the case of a homogeneous planet, on the assumed figure of the fluid. In this latter case, the solution of the problem requires, farther, that the equations be brought to a determinate form by eliminating all that varies with the unknown figure of the fluid ; and the means of doing

this are not provided for in the theory of Clairaut, which tacitly assumes that the forces urging the interior particles are derived from the forces at the upper surface, merely by changing the co-ordinates at the point of action. In the case of a homogeneous planet, the forces acting on the interior particles are not deducible, in the manner supposed, from the forces at the surface.

After showing that the equilibrium of a fluid, entirely at liberty, will not be disturbed by a pressure of the same intensity applied to all the parts of the exterior surface, the author considers the action of the forces upon the particles in the interior parts of the body of the fluid; and shows that although the forces at the surface are universally deducible from the general expressions of the forces of the interior parts, yet the converse of this proposition is not universally true, the former not being always deducible from the latter; a distinction which is not attended to in Clairaut's theory. He then investigates the manner in which these two classes of forces are connected together; establishes a general theorem on the subject; and proceeds to its application to some of the principal problems, relating to the equilibrium of a homogeneous fluid at liberty, and of which the particles attract one another with forces, first in the inverse duplicate ratio, and secondly in the direct ratio of the distance, at the same time that they are urged by a centrifugal force arising from their revolution round an axis. The author concludes with some remarks on Maclaurin's demonstration of the equilibrium of the oblate elliptical spheroid; and on the method of investigation followed in the paper published in the Philosophical Transactions for 1824. In an Appendix the author subjoins some remarks on the manner in which this subject has been treated by M. Poisson.

The reading of a paper was then commenced, entitled, "Experimental Researches in Electricity;" Eighth Series." By Michael Faraday, Esq., D.C.L., F.R.S.

June 12, 1834.

BENJAMIN COLLINS BRODIE, Esq., Vice-President, in the Chair.

A paper was read, entitled, "On the Arcs of certain Parabolic Curves." By Henry Fox Talbot, Esq., M.P., F.R.S.

The general equation to parabolic curves, (namely, $nu = v^n$; where u is the abscissa and v the ordinate,) gives for the arc of the curve an expression which, excepting in a very few instances, is transcendental. But although the length of an arc, considered by itself, cannot be assigned algebraically, yet it frequently happens that the sum of two or more arcs is capable of being so assigned, and sometimes in a very simple manner. The author has found this reduction to take place in so many instances, as to incline him to believe that it may be universally possible, provided the exponent (n) of the ordinate in the equation to the curve is a rational quantity of these reductions: he

gives a great number of examples ; but although the processes for that purpose are easy, the difficulty consists wholly in finding the proper method of treating each individual case. The author hopes to lay before the Society, on a future occasion, an account of the principles on which this branch of analysis is founded.

Mr. Faraday's Eighth Series of Experimental Researches in Electricity was resumed and read in continuation.

June 19, 1834.

FRANCIS BAILY, Esq., Vice-President, in the Chair.

The reading of Mr. Faraday's Eighth Series of Experimental Researches in Electricity was resumed and concluded.

This series is devoted to an investigation of the source, character and conditions of the electricity of the voltaic instrument, and is divided into five parts. In the first part, simple voltaic circles are considered ; and at the outset, the great question of " whether the electricity is due to contact or chemical action ? " is investigated and decided by apparently very conclusive evidence in favour of the latter. One principal experiment in favour of this decision is the following: A plate of zinc and a plate of platina were prepared ; one end of each of these was put into a vessel containing a little dilute sulphuric acid or sulpho-nitric acid, and between the other ends was placed a piece of bibulous paper moistened in a solution of iodide of potassium : the two plates did not touch each other anywhere, but still the action of the end at the one extremity was able to induce the electro-chemical decomposition of the iodide of potassium at the other. That this decomposition was due to the chemical action of the acid was proved by removing the latter ; for then the decomposition ceased. It was also farther proved by the appearance of the iodine against the *platina* ; for it went there in consequence of the passage of a current (induced by the action of the acid) having the opposite direction to that which the solution of iodide would have produced had it been the only exciting body, and metallic contact had been allowed.

The opposition of the chemical affinities at the two places where the acid and the solution of the iodide are placed, is shown when the metal plates are allowed to touch each other in the middle ; for then two opposite electric currents are produced, but that occasioned by the acid is the stronger. This opposition is farther shown in the manner in which the weaker set of affinities are overcome by the stronger (that is, those of the iodide and zinc by those of the acid and zinc) ; and this dependence and relation of the two explains at once the value of metallic contact ; for if the solution of iodide of potassium be placed between platina and platina, one of those pieces of metal touching the zinc which is immersed in the acid, then the solution of iodide does not tend to throw an electric current into circulation, because it exerts no chemical action in either direction ; and therefore

the powers active in the acid are more free to act, produce a stronger current, and effect decomposition more freely.

The chemical actions at the opposite ends of the metallic arrangement are so strongly associated and related, that in the most perfect form of experiment, action cannot occur at either end without also taking place at the other extremity to an exactly equivalent amount. This is considered by the author as the most convincing proof that in the voltaic pile the chemical and electric action are the same; that is, modes of exhibition of the same force, and as they are convertible into each other in exactly definite proportion, must have one common origin.

By using different fluids at the exciting place of action, currents of different intensity could be obtained: thus the current produced by the action of dilute sulphuric acid on zinc and platina could decompose elsewhere solution of iodide of potassium, fused protochloride of tin, or chloride of silver; but could not decompose water, muriatic acid, nitric, or the chloride or iodide of lead. Making the dilute sulphuric acid stronger, or using larger plates of zinc and platina, did not yield any advantage; but immediately that the chemical action on the zinc was increased in *intensity*, which could be done by adding only a few drops of nitric acid, then most of the latter bodies could be decomposed by a single pair of plates. A scale of initial intensities can in this way be obtained.

The electricity evolved in the voltaic pile is altogether due to that chemical action which takes place between the metal most easily acted upon and the element which unites with it; as, for instance, between the zinc and the oxygen of the water, or the chlorine of the muriatic acid, or the sulphur of hydrosulphurets, &c.; the after action of the acid in combining with the oxide, when that is the substance formed, adds nothing to the effect. The truth of this principle is deduced in the first place from the electricity evolved being the equivalent of the zinc oxidized; in the second, from the quantity of electricity being the same for the oxidation of a given quantity of zinc, whether the oxide formed is removed by an acid or an alkali; and it is supported by many other experimental reasons and proofs.

The view which the author takes of the identity of electrical and chemical action, leads him to admit that there are *two modes of action* in which the attractive power of the substances which ultimately combine, and by combining give the voltaic pile activity, can be exerted. Thus, taking zinc and platina as the two metals used, then the *third* substance must be an electrolyte; that is, a body which is decomposed when the electric current passes it; which cannot conduct the current unless it is at the same time decomposed; and which contains an element having such attraction for the zinc that the latter can take it from the element with which it is previously combined. Water is the electrolyte generally present in the voltaic pile.

Then, with respect to the attraction between the zinc and the oxygen of the water, we have it in our power to cause it to take place at once when the metal and water are in contact, the hydrogen being then set free; or we can, by using the precautions which the author

gives, cause that no action take place, unless a current be formed and the hydrogen be transferred to a distance, whilst the forces circulate in what is called the electric current. Placing the origin of the current in the chemical action, which yet could be thus virtually restrained unless the circuit was completed, the author expected to find a state of tension in the chemical or electrical forces *before* metallic contact was made or the circuit perfect, and was able at last to prove this most fully by obtaining an *electric spark* between two plates of different metals immersed in acid before they came in contact. This fact, with the former one of decomposition, fully proved that contact was not necessary to the production of the electricity in the voltaic pile.

The *second* part of this memoir contains an investigation of the following important points: namely, whether electrolytes could resist the action of an electric current if below a certain intensity; whether the intensity at which an electric current might cease to act would be the same for all bodies; and also whether the electrolytes, when thus resisting decomposition, would conduct the electricity as a metal or charcoal does, after they ceased to conduct as electrolytes, or would act as insulators. It is first proved with regard to water, that a current of a certain intensity is necessary for its decomposition, but that a current of a lower intensity is conducted by it; and that with such feeble currents, pure water conducts as well as acidulated water or saline solutions. The same condition of a certain necessary intensity of current was found to hold good also with sulphate of soda in solution with fused chloride of lead and other bodies, and is considered by analogy as extending to all electrolytes.

In the *third* part of the paper, associated voltaic circles, or the voltaic battery, is examined. From the principles and facts stated in the preceding parts, it appears evident that the association of many pairs of plates, equal in size, nature and force, cannot by any possibility increase the quantity of electricity above that which any single pair in the series could produce, taking the quantity of zinc oxidized at any one plate as the standard of development. It is easy, by using amalgamated zinc, to construct a battery in which no action shall take place on the metals, except the extremities be in communication. If a battery of ten pairs of plates be thus communicated, there is of course oxidation of each zinc plate, and a current of electricity circulates. If the contact of the extremities be continued until a certain quantity of zinc has been dissolved at any one plate, it will be found that an exactly equal quantity has been dissolved at each of the other plates; and that a certain quantity of electricity has passed, which can be taken cognizance of by the volta-electrometer. But should nine of the pairs of plates be removed and the battery be reduced to a single pair, yet when the given quantity of zinc had been dissolved there, as much electricity would have gone round the circuit as with the whole number of ten pairs, and during the evolution of which ten times the quantity of zinc had been oxidized.

This result, already proved by electro-magnetic experiments, is shown to be a necessary consequence of the construction of the pile and the manner in which its forces act. The electricity evolved by

chemical action at one pair of plates cannot pass by another pair except an equal chemical action take place there; and as the chemical and electrical action are always equivalent, the equal chemical action at the second pair will do no more than suffice to transfer forwards the forces disturbed at the first pair, and can add nothing to their quantity: but they can add to their *intensity*, and in fact the recurrence of a second chemical action at the second pair of plates has exactly the same effect as would be produced by a more intense chemical action at the first pair. In this way it is that numbers of plates give energy to the voltaic pile, and enable its power to penetrate electrolytic bodies and permeate bad conductors in a manner which could not be done by the electricity of a few pairs of plates only.

The *fourth* part of the paper relates to the resistance opposed to the electric current at the place of decomposition, and refers this at once to the resistance of the chemical affinity which has to be overcome. This of course varies with the number of places where decomposition is effected, the strength of the affinity of the elements of the decomposing body for each other, and the nature of the substance against which the decomposition is effected, and by which it may very frequently be assisted. All these are taken into account, their general, and occasionally particular, results shown, and their perfect harmony with the principles previously advanced pointed out.

In the last part of the paper some general remarks on the active voltaic battery are made, in which the influence of several distinct causes in producing a rapid change and deterioration of action is pointed out. Each of these causes is considered separately, and the effects they produce are shown to be necessary consequences of the principles already laid down as those of the voltaic battery.

The following Papers were then read:

1. "Observations on the *Teredo navalis* and *Limnoria terebrans*, as at present existing in certain localities of the British Islands." By William Thompson, Esq., Vice-President of the Natural History Society of Belfast. Communicated by J. G. Children, Esq. Sec. R.S.

The opinion which has been advanced, that the *Teredo navalis* is no longer to be found on the British coast, is shown by the author to be erroneous; for numerous specimens of that destructive animal, collected from the piles used in the formation of the pier at Portpatrick in Ayrshire, were furnished to him by Captain Frayer, R.N. (of His Majesty's Steam-packet Spitfire). Some of these specimens had attained the length of nearly two feet and a half, a magnitude at least equal to, if not exceeding, the largest brought from the Indian seas. After giving a description of the animal, the author enters into an inquiry into the agency it employs to perforate the timber which it consumes as food, and in which it establishes its habitation. He ascribes to the action of a solvent, applied by the proboscis, the smooth and rounded termination of its cell, which is afterwards enlarged by the mechanical action of the primary valves.

The author then gives an account of the natural history and opera-

tions of another animal, the *Limnoria terebrans*, of Leach, belonging to the class of Crustacea, whose depredations on timber are no less extensive and formidable than the *Teredo*. At Portpatrick it appears that both these animals have combined their forces in the work of destruction, the *Teredo* consuming the interior, and the *Limnoria* the superficial parts of the wood; the latter continuing its labours until it comes in contact with the shells of the former, so that the whole mass is speedily deprived of cohesion. It is stated, on the authorities of Mr. Hyndman and Mr. Stephen, that the *Limnoria* is already committing great ravages in the timber at Donaghadee.

2. "On the Nervous System of the *Sphinx ligustri* (Linn.) during the latter Stages of its Pupa and its Imago States; and on the Means by which its Development is effected." By George Newport, Esq. Communicated by P. M. Roget, M.D., Sec. R.S.

In a paper formerly read to the Royal Society, and printed in the Philosophical Transactions, the author has given a description of the anatomy of the nervous system of the *Sphinx ligustri* in its larva, and the earlier periods of its pupa, state; and he has since prosecuted the inquiry then commenced, following the changes of structure through the remaining stages, until the insect has arrived at its full development. He enters into minute details of all these changes, which vary considerably in the rapidity with which they take place at different periods, according as the vital powers are called into action by external circumstances, or become exhausted by their efforts at effecting the growth or modifying the form of different parts. Thus the ganglia and nervous cords undergo great changes both in their form and situation, and also in their number, during the passage of the insect from the larva to the pupa state; and after these changes have been carried to a certain extent, they are suspended for several weeks, during which the insect remains in a state of hybernation; but at the expiration of this period the changes again proceed, and are continued uninterruptedly, till the insect attains its ultimate or perfect stage of development. The *Sphinx ligustri* remains in the pupa state during at least forty-two or forty-three weeks; thus affording ample opportunities of examining the whole progress of the changes which take place in the structure of different parts. The concentration of the nervous system, which was commenced in the larva, proceeds to a much greater extent while the insect is inclosed in the pupa, and is continued for a short time after it has assumed the imago state. The double origin and connexions of the nerves distributed to the wings are described, and a conjecture offered as to the object of this arrangement, which appears designed to establish a harmony of action between the wings, in those insects, especially, which are remarkable for velocity and power of flight; a different disposition being adopted in those which fly with less regularity or speed. The nerves of the organs of sense, as the antennæ, eyes, proboscis, and apparatus for manducation, are traced and minutely described, and a comparison instituted between them and the nerves which have similar offices in vertebrated animals. The author traces the origin and course of the

nerve corresponding to the *pneumo-gastric*, or *par vagum*, and shows that it is distributed chiefly to the organs of digestion and the respiratory passages. He next describes the anterior lateral cephalic ganglia, which, from their position, might be regarded as auxiliary brains. The situation and course of another nervous tract, which from its extensive connexions and peculiar mode of distribution is considered as corresponding to the sympathetic system, are also traced. The author notices a set of nerves which, adopting the views of Sir Charles Bell, he considers as analogous to those which the latter has denominated the respiratory nerves of vertebrated animals; and among a great number of interesting observations, of which it is impossible to give any abridged account, one of the most remarkable is the discovery that the primary longitudinal nervous cords of insects consist of two tracts, the one situated over the other, corresponding to the two columns of which the spinal cord consists in vertebrated animals; the one appropriated to sensation, and the other to voluntary motion; the nerves from each of these tracts being variously combined, according to the purposes they are designed to fulfil. This important distinction, which was first traced in the nervous cords of the Lobster, was afterwards distinctly observed by him in the *Scorpion* and the *Scolopendra*, and lastly, in several species of insects, as the *Gryllus viridissimus*, the *Carabus*, the *Papilio urticæ*, and the *Sphinx ligustri*. Numerous drawings of the parts described accompany the paper.

3. "Observations on the Torpedo, with an account of some additional experiments on its Electricity." By John Davy, M.D., F.R.S., Assistant Inspector of Army Hospitals.

The first part of this paper is occupied by an investigation of the circumstances attending the fœtal development of the Torpedo. In the first stage of embryonic growth which the author had an opportunity of observing, when the embryo was about seven tenths of an inch in length, it had neither fins nor electrical organs, nor any appearance of eyes; it exhibited short external branchial filaments, not yet carrying red blood; and there was a red spot in the situation of the heart, communicating by red vessels in the umbilical cord with the vascular part of the egg. There is no membrane investing the fœtus, as is the case with some species of *Squali*; nor any fluid in the uterine cavity; neither could the author find any urea or lithic acid in that cavity. By taking the mean of many observations, it appeared that the weight of the egg, before any appearance of the embryo, is 182 grs., and after its appearance, including the weight of the latter, 177 grs.; while the weight of the mature fish is about 479 grs.; showing an augmentation of more than double. Thus it differs remarkably, in this respect, from the fœtal chick, which at its full time weighs considerably less than the original yolk and white from which it is formed. No communication can be traced between the fœtus of the Torpedo and the parent, through the medium of any vascular or cellular structure; and the stomach of the former is always found empty. Hence the only apparent source of nourishment is absorption from the surface;

and the author states his reasons for believing that the branchial filaments are the principal absorbing organs, the materials they receive being chiefly employed in the construction of the electrical organs, while those which enter into the composition of the body generally are absorbed by the general surface of the foetus. The author is led, from his researches, to the conclusion that the mode of reproduction in the *Torpedo* is intermediate between the viviparous and the ovoviviparous.

In the second part of the paper, the author discusses the question as to the number of species of the genus *Torpedo* existing in the Mediterranean; and concludes that there are only two, viz. the *Ochiatella* and the *Tremola*.

4. "Appendix to a former Paper on Human Osteology." By Walter Adam, M.D. Communicated by Dr. Prout, F.R.S.

This appendix contains linear representations of various dimensions of the bones of the human body, both male and female, with a view to facilitate the comparison of the human frame with that of other animals, and reduce it to definite laws. The author states that many of the rectilinear dimensions of human bones appear to be multiples of one unit, namely, the breadth of the cranium directly over the external passage of the ear; a dimension which he has found to be the most invariable in the body. No division of that dimension was found by him to measure the other dimensions so accurately as that by seven, or its multiples. Of such seventh parts there appear to be twelve in the longitudinal extent of the back, and ninety-six in the height of the whole body.

5. "On the Repulsive Power of Heat." By the Rev. Baden Powell, M.A., F.R.S., Savilian Professor of Geometry in the University of Oxford.

The expansion of bodies by heat appearing to imply a mutual repulsion of their particles, it becomes a question whether such repulsive power may not be excited by it between particles or masses of matter, at sensible as well as insensible distances. After noticing the partial investigations of this question by Libri, Fresnel, Saigey, and Professor Forbes, the author describes the methods he has employed with a view to its solution, and which consisted in applying heat to two lenses of glass, pressed together so as to exhibit the colours of thin plates; the variation of the tints furnishing exact indications of the most minute changes of distance between the surfaces, by whatever causes they may be produced. The conclusion he deduces from his experiments, conducted on this plan, is that the separation of the surfaces is of a different character, and is greater than can be accounted for by the mere change of figure produced by the heat; and is therefore in part to be ascribed to a real repulsive action between the surfaces of the glasses derived from the power of heat. He also found, on trying similar experiments with glass in contact with a metallic surface, that the results were considerably influenced by the radiating power of the latter; the effect being increased when this power was greater, and

also by all other causes tending to the more rapid communication of heat. This is still more apparent when the coloured rings are formed in a thin plate of water interposed between the lenses, and where the effects are independent of radiation.

6. "Analysis of the Moira Brine Spring near Ashby-de-la-Zouch, Leicestershire, with Researches on the Extraction of Bromine." By Andrew Ure, M.D., F.R.S.

The water derived from the spring in question is raised by means of a pump from the coal mines in the neighbourhood of Ashby-de-la-Zouch, is much used as medicinal baths, and is also administered internally, principally as a remedy for bronchocele and scrofulous tumors. The result of the analysis made by the author, is that it contains per gallon,

Bromide of sodium and magnesium	grs. 8
Chloride of calcium	851.2
————— magnesium	16
————— sodium	3700.5
Protoxide of iron, a trace	

Solid contents 4575.7

After removing from the water the deliquescent chlorides of lime and magnesia by the addition of carbonate of soda, he transmits through the mother liquor, consisting of chloride and bromide of sodium, a current of chlorine gas, till it communicates the maximum golden tint, and then adds sulphuric æther, which, by agitation, carries with it to the surface the bromine and chlorine, constituting a reddish yellow stratum. The proportion in which these two elements exist in the evaporated solution may be ascertained with the greatest nicety by the addition of a solution of nitrate of silver; the method of calculation for this purpose being detailed by the author.

7. "On the Nature and Origin of the Aurora Borealis." By the Rev. George Fisher, M.A., F.R.S.

The author deduces from his own observations made during a residence of two winters in high northern latitudes, taken in conjunction with the concurring testimony of various navigators and travellers, the general fact that the Aurora Borealis is developed chiefly at the edge of the Frozen Sea, or wherever there is a vast accumulation of ice; and he conceives that it is produced in situations where the vapours of a humid atmosphere are undergoing rapid congelation. Under these circumstances, when viewed from a distance, it is seen fringing the upper border of the dark clouds, termed the "sea blink," which collect over these places; and it generally forms an arch a few degrees above the horizon, shooting out vertical columns of pale yellow light. He concludes that the Aurora Borealis is an electrical phenomenon, arising from the positive electricity of the atmosphere, developed by the rapid condensation of the vapour in the act of freezing, and the induced negative electricity of the surrounding portions of the atmosphere; and that it is the immediate consequence

of the restoration of the electrical equilibrium by the intervention of the frozen particles, which being imperfect conductors, become luminous while transmitting this electricity. In tropical and temperate climates this phenomenon does not occur, because the electric equilibrium is restored by means of aqueous vapours, a process which often gives rise to thunder and lightning, but never to the Aurora Borealis; the latter being peculiar to clear, cold and dry weather.

8. "Théorie Balistique." Par M. Le Comte de Prédaval. Communicated by Dr. Roget, Sec. R.S.

The author inquires into the influence which he conceives the following circumstances may have on the path of a projectile on the surface of the earth; namely, first, the direction of the line of projection relatively to the meridian or cardinal points; secondly, the latitude of the place; and thirdly, the barometric conditions of the atmosphere.

9. "On the Atmospheric Tides and Meteorology of Dukhun, in the East Indies." By Lieut.-Colonel W. H. Sykes, F.R.S.

The author premises detailed descriptions of the various instruments used in the meteorological observations recorded in this paper, and of the methods employed in obtaining his results; of which the great features are the barometrical indications of diurnal and nocturnal atmospheric tides, embracing two maxima and two minima in the twenty-four hours. The following are the chief topics noticed in the paper, and the principal facts established by these inquiries: namely, 1. The removal of the doubts entertained by Humboldt, founded on the authority of Horsburgh, of the suspension of the atmospheric tides during the monsoon in Western India; the existence of the four atmospheric tides already mentioned, and their occurrence within the same limiting hours as in America and Europe; the greatest mean diurnal oscillations in Dukhun taking place in the coldest months, and the smallest in the damp months; whilst at Madras, the smallest oscillations are in the hottest months, and in Europe it is supposed that the smallest oscillations are in the coldest months. 2. The regular diurnal and nocturnal occurrence of the tides, without a single case of interversion, whatever may be the thermometric or hydrometric indications, or the state of the weather; storms and hurricanes only modifying, but not interrupting them. 3. The anomalous fact of the mean diurnal oscillations being greater at Poona, at an elevation of 1823 feet, than at the level of the sea, in a lower latitude, at Madras. 4. The fact of the diurnal tides, at a higher elevation than Poona, being less, whilst the nocturnal tides are greater than at Poona; and the seasons apparently not affecting the limiting hours of the tides. 5. The maximum mean pressure of the atmosphere being greatest in December and January; then gradually diminishing until July and August; and subsequently increasing to the coldest months. 6. The very trifling diurnal and annual oscillations compared with those of extra-tropical climates. 7. The annual range of the thermometer being less in Dukhun

than in Europe, but the diurnal range much greater; the maximum mean temperature occurring in April and May, and gradually declining until December and January; and the observed mean temperature of places on the continent of India being much higher than the calculated mean temperature according to Meyer's formula. 8. The mean annual dew-point being higher at half-past nine o'clock than either at sunrise or at four in the afternoon; the dew-point being highest during the monsoons, and lowest during the cold months, and varying considerably within very short distances; being, for example, remarkably contrasted in Bombay and Dukhun; and the frequent occurrence of dew quite locally and under anomalous circumstances. 9. The amount of rain in Dukhun being only 20 per cent. of that falling in Bombay, 90 or 100 miles to the westward. 10. The wind being principally from the west and east, and rarely from the opposite quarters. 11. The great abundance of electricity under certain circumstances. 12. The rare occurrence of fogs. 13. The great amount of solar radiation; and lastly, the singular opacity of the atmosphere during hot weather, giving rise occasionally to the mirage. A variety of tables containing the records of meteorological observations, with instruments, accompany the paper.

10. "On the Ova of the *Ornithorhynchus paradoxus*." By Richard Owen, Esq. Communicated by W. Clift, Esq., F.R.S.

The author, in this paper, has prosecuted more immediately and more minutely than in his former communication, the inquiry into the structure of the ovary of the *Ornithorhynchus*, with a view to determine its exact relations with that of the normal Mammalia, and of the oviparous Vertebrata. He has obtained from this investigation the full confirmation of the truth of the opinion he had previously formed, that lactation might coexist with a mode of generation essentially similar to that of the Viper and Salamander; and this fact has been further established by the subsequent examination which he has made of the uterine fœtus of the Kangaroo.

The author traces the regular gradation which obtains in different orders of Mammalia in which true viviparous or placental generation takes place, towards the ovo-viviparous or oviparous modes, in which the exterior covering of the ovum never becomes vascular, and shows that the *Ornithorhynchus* constitutes a connecting link in this chain.

Drawings illustrative of the anatomical descriptions of the parts examined by the author accompany the paper.

11. "Observations with the Horizontal and Dipping Needles, made during a Voyage from England to New South Wales." By James Dunlop, Esq. Communicated by Capt. Beaufort, R.N., F.R.S.

This paper contains a very numerous and uninterrupted series of magnetical observations, made in the circumstances stated in the title, and extending about 180 degrees in longitude and 100 degrees in latitude. The apparatus, of which a detailed description is given, was suspended from the roof of the cabin, and no alteration was made in its suspension from the beginning to the end of the voyage.

12 "Experiments on Light." By Henry Fox Talbot, Esq., M.P., F.R.S.

In the first section of this paper, an account is given of certain appearances presented by transparent objects, and especially saline crystals, viewed through a microscope, when illuminated by polarized light. For this purpose, the first polarizing medium, consisting of the arrangement of single-image calcareous spar, invented by Mr. Nichol, is fixed beneath the stage of the microscope; and the second, which is similar to it, is interposed between the eye-glass and the eye, and is capable of being turned on its axis, so as either to allow of the transmission of the whole of the light polarized by the first medium, or to intercept the whole of it, according as its position is similar, or at right angles to the former. In the latter case, any substance which has the property of depolarizing the light transmitted to it by the first medium, will appear luminous, while the rest of the field of view is quite dark, and will exhibit the most brilliant colours, dependent on its thickness and position; so that if the stage of the microscope be turned round, the colour of each crystal is seen to change, and gradually to assume the complementary tint. Other variations in the appearances are produced by interposing a plate of mica, which gives a general tint to the whole field of view, and modifies the colours of the objects viewed; and also by turning the polarizing eye-piece, so that the whole of the polarized light is transmitted; when crystals, which would be white if viewed by ordinary light, may be made to assume various colours, and even sometimes to appear perfectly opaque; a result which does not seem to be in accordance with that which theory would lead us to expect.

The second section is occupied with the development of a principle which the author conceives is extensively applicable to the purposes of photometry, or the accurate measurement of the intensity of light. It is founded on the well-known experiment of the appearance of a uniform grey tint presented by a circle, partly white and partly black, when made to revolve rapidly; the intensity of the light being regulated by the proportional spaces occupied by each colour. Several variations of this experiment are described, with a view to its practical application to the proposed object. The author also suggests the employment of methods founded on a similar principle to the measurement of quantities in various other branches of physical science; for example, that of high temperatures.

13. "On the Mummy Cloth of Egypt; with Observations on the Manufactures of the Ancients." By James Thomson, Esq., F.R.S. Communicated by Dr. Roget, Sec. R.S.

By subjecting the threads of various specimens of cloth, enveloping Egyptian mummies, to accurate microscopic examination, which was done at the request of the author by Mr. Bauer, it was ascertained that they were formed exclusively of the fibres of linen, and not of cotton, as had been supposed; a conclusion which is corroborated by other considerations stated by the author. The paper is accompanied by drawings, exhibiting the appearances of the threads both of cotton

and of linen, when highly magnified; and concludes with an historical disquisition on the cloth manufactures of the ancients, and the mention of experiments from which it is inferred that the principal colouring materials employed in dyeing the yarn were indigo and saffron.

14. "An Account of some Experiments to measure the Velocity of Electricity, and the Duration of Electric Light." By Charles Wheatstone, Esq., Professor of Experimental Philosophy in King's College, London. Communicated by Michael Faraday, Esq., F.R.S.

The continuance for a certain time of all luminous impressions on the retina prevents our accurately perceiving, by direct observation, the duration of the light which occasions these impressions, but by giving the luminous body a rapid motion, which produces the appearance of a continued train of light along the path it has described, its condition at each moment may be ascertained, and consequently its duration determined. The same law of our sensations precludes us from direct perception of the velocity with which the luminous cause is moving, as the whole of its track, for a certain distance, appears to be equally illuminated; but by combining a rapid transverse motion of the body from which the light proceeds, with that which it had before, its path may be lengthened to any assignable extent, and both its direction and its velocity will admit of measurement. The author gives various illustrations of this principle, and of his attempts to apply it to appreciate the duration and the velocity of the electric spark. His first experiments were made by revolving rapidly the electric apparatus giving electric sparks; but in every instance they appeared to be perfectly instantaneous. He next resorted to the more convenient plan of viewing the image of the spark reflected from a plane mirror, which, by means of a train of wheels, was kept in rapid rotation on a horizontal axis. The number of revolutions performed by the mirror was ascertained, by means of the sound of a siren connected with it, and still more successfully by that of an arm striking against a card, to be 800 in a second. The angular motion of the image being twice as great as that of the mirror, it was easy to compute the interval of time occupied by the light during its appearance in two successive points of its apparent path, when thus viewed; and it was ascertained that the image passed over half a degree (an angle which, being equal to about an inch, seen at a distance of ten feet, is easily detected by the eye,) in the 1,152,000th part of a second. The result of these experiments, as regarded the duration of the spark, was that it did not occupy even this minute portion of time; but when the electric discharge of a battery was made to pass through a copper wire of half a mile in length, interrupted both in the middle, and also at its two extremities, so as to present three sparks, they each gave a spectrum considerably elongated, and indicating a duration of the spark of the 24,000th part of a second. The sparks at both extremities of the circuit were perfectly simultaneous, both in their period of commencement and termination; but that which took place in the middle of the circuit, though of equal duration with the former, occurred later, by at least the millionth part

of a second, indicating a velocity of transmission from the former point to the latter of nearly 288,000 miles in a second; a velocity which exceeds that of light itself.

The following letter was read from the Chair.

" British Museum, June 19th, 1834.

" MY DEAR SIR,—His Royal Highness the President requests that, when you adjourn the meeting this evening to the 20th of November, you will have the goodness to express his great regret that, unfortunately, the state of his health and sight has lately been such as to render it impossible for him to preside at the ordinary meetings of the Society so frequently as it was his anxious wish to have done. His Royal Highness begs you will assure the Society that his absence has been occasioned by the cause alluded to alone, and from no feeling of diminished interest in the prosperity of the Royal Society, or of regard and respect for the Fellows; on the contrary, His Royal Highness hopes that, by the blessing of Providence, his health will soon be in all respects so far re-established as to enable him, on the reassembling of the Society, to resume the chair, and fill it with that uninterrupted regularity which it is His Royal Highness's most anxious wish to observe, in whatever duty he undertakes.

" Ever, my dear Sir, faithfully yours,

" JOHN GEORGE CHILDREN.

" P.S.—His Royal Highness requests you will in his name bid the Fellows heartily farewell till he meets them again in November."

" Francis Baily, Esq., V.P. R.S."

The Society then adjourned over the long vacation, to meet again on the 20th of November.